United States Department of Agriculture

FOREST HEALTH ASSESSMENT AND BIOLOGICAL EVALUATION OF FRIENDSHIP HILL NATIONAL HISTORIC SITE

Forest Service Northeastern Area State and Private Forestry September 2018

All photos by Amy Hill, Heather Smith, and Karen Sykes, U.S. Forest Service, unless otherwise indicated.

Forest Health Assessment and Biological Evaluation of Friendship Hill National Historic Site

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FORWARD

This document addresses the forest health concerns at Friendship Hill (FRHI) National Historic Site. Communication and cooperation have been fostered through the development of a coordinated Forest Health Biological Evaluation of the Park's natural resources. This has resulted in a strengthened partnership between the National Park Service and the U.S. Forest Service. The objective of this Forest Health Assessment and Biological Evaluation is to develop and increase the management efficiency of forest health issues should they arise at the Park over the next 5 to 15 years. This document focuses on evaluating the current forest resources, identifying potential forest health issues of concern, and making management recommendations to protect and enhance all resources.

ACKNOWLEDGEMENTS

We would like to thank the following people for their time and assistance with this report. MaryEllen Snyder and Nancy Smith of the National Park Service contributed their time by assisting us on field visits to the Park. Their local knowledge of past and future projects at Friendship Hill was instrumental in helping develop a forest health management strategy. Their contributions and support are greatly appreciated. We'd also like to thank NPS interpreter James Tomsek, whose interpretative knowledge of the site was helpful in understanding the changes that have occurred over time. We also thank Stephanie Perles of the National Park Service for providing us with documentation to describe the vegetation communities and conditions at Friendship Hill. Without her expertise and inventory information, this Forest Health Assessment and Biological Evaluation would not have been possible.

EXECUTIVE SUMMARY

Friendship Hill (FRHI) National Historic Site was field visited during October and November 2017, and from April to July 2018. The purpose was to determine forest types; assess forest health; identify existing and future insect, disease, and invasive issues; and prepare a document that will assist the National Park Service (NPS) in making management decisions.

Documents compiled by the NPS Northeast Region (Perles and others 2006, Perles and others 2010, Perles and others 2014) provided valuable information on forest types, vegetation communities, vegetation classification, and nonnative plant species, which were explored during visits to FRHI. These technical and natural resource reports provided biological data to address natural resource management issues and were used as a basis for the Forest Service evaluation of FRHI.

Management recommendations and alternative strategies, consistent with NPS objectives, are provided here to protect or enhance all resources that are present. In some cases prescriptions, treatments, and recommendations are site specific.

Treatment of Invasive Species

To efficiently control invasive species, it is recommended that the Park adopt an approach to invasive species management that efficiently allocates resources to this overwhelming threat.

- Prioritize biologically and culturally important sections of the Park (typically small areas) to reduce invasive species, encourage native species, and maintain these areas free of invasive species.
- Enlist Park and Forest Service personnel in early detection of new invasive species, as well as rapid response, to eliminate newly established populations of these species. The time of initial invasion is the most cost-effective time to manage an invasive species. The Eastern Rivers and Mountain Network can provide information on the FRHI early detection-rapid response program.
- Dedicate resources to and cultivate partnerships that bring biological controls to the Park for well-established abundant species that cannot be otherwise controlled Park-wide.

- Utilize the NPS Exotic Plant Management Team (EPMT) to provide assistance with on-the-ground invasive species management as well as funding for Park-specific invasive plant projects.
- Review specific treatments for most invasive plant species, which are found in the Forest Health Section of this document.
- Thoroughly clean all equipment used in these treatments before entering Park property to avoid introducing additional invasive species. (https://www.usbr.gov/mussels/prevention/docs/EquipmentInspectionandCleaningManual2010.pdf)
- Park resource managers should make it a priority to prevent the introduction of new invasive species through awareness and continued monitoring and management of invasive species that are currently present. Managing for and maintaining a diverse forest composition will also help keep the forest resilient for surviving infestations of forest pests and pathogens.

In the 2006 vegetative classification of FRHI, Perles and others observed that the Successional Old Field association contained particularly high abundances of invasive shrub species (Zimmerman and Yoder 2006). Morrow's honeysuckle (*Lonicera morrowii*), autumn olive (*Elaeagnus umbellata*), and multiflora rose (*Rosa multiflora*) were the most problematic exotic species in this association, although Japanese honeysuckle (*Lonicera japonica*) and Japanese stilt grass (*Microstegium vimineum*) are also common. Without proper management, these species threaten and impede the succession to native forest types. Therefore, the management of these former agricultural fields should be a priority for the Park.

The recommended actions address the control of invasive species and protection of eastern hemlock (*Tsuga canadensis*), designate desired target vegetation structure and composition, and outline management actions to achieve the desired target conditions. The implementations of these actions, specifically for the Successional Old Field vegetative type, will facilitate the control of invasive species and the restoration of natural vegetation associations.

Immediate Actions

- A group of eastern hemlock on the east side of Ice Pond Run and other individuals scattered throughout the Park need to be treated for hemlock woolly adelgid (*Adelges tsugae*). To date, hemlock woolly adelgid (HWA) has not been detected at FRHI, but if left untreated from HWA infestations, the existing hemlocks will eventually die and will need to be removed due to hazards to the public. Chemical treatment is recommended for these trees to continue species diversity, reduce the potential for trees of concern, and provide shade to reduce the establishment and spread of invasive plant species currently established.
- Treat invasive species, especially any newly discovered species, such as black jetbead (*Rhodotypos scandens*), or those not covering a large area. Infestations of black jetbead were found along the Trailhead Loop, Inner Loop near Dublin Run, and Ice Pond Run Loop. The infestations along the Ice Pond Run Loop were treated in the fall of 2017, and no resprouting was observed during the summer of 2018. Continue to monitor this site in 2019 in case any remaining root system is alive to resprout new growth. Early treatments may eradicate the infestations before they spread to other parts of the Park.
- Treat tree of heaven (*Ailanthus altissima*) (TOH) saplings adjacent to the visitor parking lot and on top of the old stone cistern. Although an intensive and successful TOH eradication program was implemented in 2007-2010, monitoring and treatments should be carried out to prevent spread and eliminate any TOH before they reach sexual maturity.
- Restoring the Successional Old Fields in the Park should be a priority through the following actions:
  - Target either the Tulip Poplar-Beech-Maple or Northern Red Oak-Mixed Hardwoods forest types to reforest the Successional Old Fields by selecting existing healthy seedlings or saplings and

protecting them with tree shelters or fencing until they are free to grow. Herbicide around healthy saplings to reduce competition. Treat invasive species.
    - Remove tree species that do not fit into the target forest types (insect infested or diseased); otherwise they will compete with the younger trees.
    - Interplant the Successional Old Fields with the Tulip Poplar-Beech-Maple or Northern Red Oak-Mixed Hardwoods species if needed.
    - Do not plant beech, ash, or hemlock because they currently have insect and disease issues.
    - Select ¼- to ½-acre areas within the grassy areas and the Successional Old Fields (or whatever size the Park deems necessary or manageable) to remove all woody species and convert to pollinator habitat.
- Monitor the trails for dead or dying ash trees and remove any whose felling length will cross trails, parking lots, and any area where the public and employees are at risk from falling trees. This is a safety issue that should be addressed throughout the Park.
- Remove the autumn olive plants adjacent to the statue of Albert Gallatin along the walkway to the Gallatin House. Replant with native species.
- Restore wetland functions and values to the Upper and Lower Pond areas.

Yearly Actions
- Monitor for any open, sunny spaces created by dead or fallen trees and establish new trees by protecting selected saplings with tree shelters or other protection methods.
- Mowing around the house grounds should be done with care as to not further damage the above-ground roots of trees and other vegetation.
- Consider delaying mowing in areas when clover is flowering to allow pollinators to forage.
- Monitor oaks for gypsy moth egg masses and contact the Forest Service at the Morgantown Field Office for assistance if found.
- Monitor the beech trees for beech bark disease and contact the Forest Service at the Morgantown Field Office for assistance if found.
- Monitor for tree of heaven and request assistance from the Morgantown Field Office if it's making a comeback or if seed-producing trees are found.
- Monitor for any insect or disease described in this report and contact the Morgantown Field Office if there are identified or unidentified insect or disease issues.
- Monitor oaks in the Alee and along the road to the maintenance area for signs of decline.
- Treat newly established invasive plant species and those not covering a large area to prevent spread.

In Case of Wildfire

Wildfire can be both destructive and beneficial. The usual response to wildfire is to extinguish it before it destroys woodlands, vegetation, and structures. After many years of fire exclusion, an ecosystem that needs periodic fire becomes unhealthy. Trees are stressed by overcrowding, fire-dependent species disappear, and flammable fuels build up and become hazardous. Sometimes the right fire needs to be at the right place at the right time to reduce hazardous fuels; minimize the spread of pest insects and disease; remove unwanted species that threaten native species; and promote the growth of trees, wildflowers, and other plants.

If a decision is made to allow wildfire to burn sections of the Park for the purposes of restoring oak and other ecosystems or controlling invasive species, contact the Bureau of Forestry and request a fire map for the Park's vegetation that shows the areas of the Park that would likely benefit from fire, as well as the areas from which fire should be immediately suppressed. Use this map to determine fire containment boundaries to best manage the forests within the Park.

FAYETTE COUNTY, PENNSYLVANIA

County Description

Fayette County is located in southwestern Pennsylvania adjacent to Maryland and West Virginia. The center of the county is about 45 miles south and east of Pittsburgh. The county was created on September 26, 1783, from part of Westmoreland County and named after the Marquis de Lafayette. Its county seat is Uniontown. As of the 2010 census, the population was 136,606.

The southern boundary is the Mason and Dixon Line, which borders West Virginia and Maryland. The entire western boundary is the Monongahela River. The eastern section of the county is mountainous with Chestnut Ridge rising to more than 2,900 feet. This area is sparsely populated, which is physiographically different from the more urban and gently rolling terrain of the western half.

Fayette County is part of the Pittsburgh, PA Metropolitan Statistical Area. (https://en.wikipedia.org/wiki/Pittsburgh-New_Castle-Weirton,_PA-OH-WV_Combined_Statistical_Area)

According to the U.S. Census Bureau, the county has a total area of 798 square miles, of which 790 square miles is land and 8.0 square miles (1 percent) is water. The western portion of the county contains rolling foothills and two valleys along the Monongahela and Youghiogheny Rivers. The eastern portion of the county is highly mountainous and forested. Many coal mines are located within the area.

Fayette County is generally a rural area and features four-lane access to the city of Pittsburgh and several of its major suburban areas. State highway systems directly connect with Pittsburgh to the north and Morgantown, WV, to the south.

Geologic Setting

Fayette County is underlain by a sequence of sedimentary rock including sandstone, siltstone, claystone, and limestone. The geologic structure is characterized by open folds called synclines and anticlines, which include four major anticlines and four synclines: the Laurel Hill anticline, Ligonier syncline, Chestnut Ridge anticline, Uniontown syncline, Fayette anticline, Lamber syncline, Brownsville anticline, and Port Royal syncline. The Chestnut Ridge anticline is the western boundary of the Allegheny Mountain section of the Appalachian Plateau Province.

FRHI-Specific Geology

A comprehensive geology resources report was completed for FRHI in 2008 (Thornberry-Erlich 2008). Findings included issues with acid mine drainage and heavy metal contamination; subsidence concerns; water erosion along the Monongahela River; geologic hazards such as slumps, landslides, and rock falls on the steep terrain along the Monongahela River; and the possibility of fossiliferous formations that will need to be protected. It's unknown whether these formations exist or have been found. View the report. (https://irma.nps.gov/DataStore/DownloadFile/426453)

Archeological, Cultural, and Historic Sites

- Fort Necessity is a reconstructed historic stockade that was originally built by George Washington to defend against an attack during the French and Indian War. Located in Wharton Township, it is now operated as a National Battlefield.
- The National Road, also known as the Cumberland Road, bisects Fayette County. It was the first significant roadway to be paid for by the Federal government, connecting Baltimore, MD, to Vandalia, IL. US 40 follows the path of this historic toll road.
- Two historic fixtures from the National Road exist within Fayette County's borders. Searight Toll House in Menallen Township is one of few remaining toll collection stops along the old route. The

Mount Washington Tavern, a unit of Fort Necessity National Battlefield, is a classic example of an early 19th-century inn.

- Fallingwater, architect Frank Lloyd Wright's most famous home, is located atop a flowing waterfall in Stewart Township. His lesser known Kentuck Knob is also located within the same municipality.
- Friendship Hill, the subject of this document and the home of the little-known but highly influential early-19th-century political figure Albert Gallatin, is maintained as a National Historic Site. It is located in Springhill Township.
- The town of Perryopolis was designed by George Washington during his career as a surveyor. It includes a restored grist mill that once served as a business venture for the future president.

FRHI-Specific Cultural Resources

In addition to the original Gallatin House, its additions, other structures, and the historic roads, two graves occupy the site. Sophia's Grave, on the west side of the property, commemorates Sophia Allegre Gallatin, Albert Gallatin's first wife. The other cemetery, called the Thomas Clare Cemetery and Friendship Hill Cemetery, lies in the northeast section of the property along the Main Loop Trail. Mr. Clare originally emigrated from Ireland and was one of the first settlers in Fayette County. He and Albert Gallatin were friends and business partners.

No definite prehistoric archeological sites or artifacts have been found on the property (USDI National Park Service 1982), but there is a possibility that some may exist. A further archeological investigation is needed.

Soils

Property-specific soils data that determines soil conditions, site class, site index, suitability for construction, and a multitude of other soil information is readily available and easily found by using the Natural Resources Conservation Service's Web Soil Survey. (https://websoilsurvey.nrcs.usda.gov/app/)

FRHI-Specific Soils

The alluvial deposited soils along the Monongahela River are deep and well drained to poorly drained. At one time crops were grown in the floodplain along the Monongahela River, which is now the Sycamore Forest vegetative type.

The soils in the uplands are suited for farming according to the Fayette County Soil Survey, but there are limitations for building and road construction because of the steep slopes on the escarpment and potential for flooding along the river (USDI National Park Service 1982).

A site-specific soil survey was completed at FRHI by the Park Service in 2013 (USDA and USDI 2013). It's a 169-page report and too large to include in this report. View the soil survey report online. (https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/pennsylvania/PA051/0/Fayette.pdf)

Water Resources

All of Fayette County is in the Monongahela River watershed, which is part of the Ohio and Mississippi watersheds. Two of the principal tributaries of the Monongahela River, the Youghiogheny and Cheat Rivers, flow through Fayette County.

The Monongahela is formed by the confluence of the West Fork River and the Tygart Valley River at Fairmont, WV. The river is navigable its entire length with a series of locks and dams that maintain a minimum depth of 9 feet to accommodate coal-laden barges. In southwestern Pennsylvania, the Monongahela is met by two major tributaries: the Cheat River, which joins it at Point Marion in Fayette County, PA and the Youghiogheny River, which joins it at McKeesport in Allegheny County, PA.

The Youghiogheny is a 134-mile river whose headwaters rise in northern Preston County, West Virginia, southeast of the town of Aurora and near Backbone Mountain. It flows north-northeast into Garrett County, Maryland, flowing north past the county seat of Oakland. The river enters southwestern Pennsylvania on the border between Fayette and Somerset counties. It flows northwest through a gap in Chestnut Ridge and then past Connellsville, PA. It joins the Monongahela River from the southeast at McKeesport, PA.

The Cheat is a 78-mile river that forms at Parsons, WV, by the confluence of Shavers Fork and Black Fork. It then flows northeast through the Cheat Canyon gorge from Albright, WV collecting Big Sandy Creek before entering Monongalia County, WV, where a hydro-electric dam just south of the Pennsylvania border causes it to widen as the Cheat Lake Reservoir. It then flows for a short distance through southwestern Fayette County, PA, before joining the Monongahela River at Point Marion. Upstream of its dam, the Cheat is one of the largest undammed watersheds in the Eastern United States.

In addition to major rivers and numerous streams, Fayette County has an abundant groundwater resource (McElroy 1988) that is usually around 55 feet in median depth throughout the county.

FRHI-Specific Water Resources

The Monongahela River forms the north and west borders of FRHI. At one time the Monongahela served as a water source for a sawmill that was located near the Pennsylvania Railroad during a timber sale that occurred sometime after 1923 (Roddy and Hammons 1986).

Four streams originating within FRHI include Dublin Run, Ice Pond Run, Rhododendron Run, and South Run. Ice Pond Run is the longest of the four streams and is severely impaired with acid mine drainage (AMD) originating from an old Winstead coal mine near Parcel 3. At least 14 other streams with some AMD flow into Ice Pond Run, and their contributions may impact it during periods of high precipitation and flows (Boone and Lisk 2002). Two pilot-scale wetlands were constructed along Ice Pond Run in 1986 and 1988 to mitigate AMD but were not successful due to design flaws (U.S. Department of the Interior 1988) (Hyman and others 1990) (Sibrell and others 2003). Remnants of these wetlands exist today, but do not function as AMD mitigation (figure 1).

Figure 1. Old wetland from pilot-scale research project.

Two water resource reports were developed in 2001 and 2006. The *Hydrological Assessment of Ice Pond Acid Mine Drainage Research Project* (Boone and Lisk 2002) was designed to survey all the surface hydrology of Ice Pond Run and to investigate the water quality of the stream. Ice Pond Run was treated for AMD, and the report describes the various streams feeding into it and the mitigation treatments used.

The second document from 2006 is entitled *Aquatic Resource Assessment of Fort Necessity National Battlefield and Friendship Hill National Historic Site* (Tzilkowski and Sheeder 2006). It describes the fish and macroinvertebrate inventories that were conducted during 2005 in both FRHI and Fort Necessity National Battlefield.

Both reports are listed in the Literature Cited section of this report.

From 2000 to 2001 a new process utilizing pulsed fluidized limestone beds was tested for the remediation of AMD at FRHI. A 230 liter-per-minute treatment system was constructed and operated over a 14-month period from June 2000 through September 2001. Over the course of operation, 50 million liters of AMD were neutralized to an average pH of

6.5. This system is no longer operating. Currently the pH of Ice Pond Run after it crosses Route 166 and into the Park was measured at 4.

Sophia's Pond, which is the headwaters for Rhododendron Run, is the only free-flowing pond within the Park. It was sampled with backpack electrofishing gear in 2005 (Tzilkowski and Sheeder 2006). It contained several macroinvertebrate taxa typically found in ponds (e.g., dragonflies) and was dominated by midges (*Chironomidae species*). Fish, frogs, dragonflies (figure 2), and water striders (*Gerridae species*) were observed during July 2018. The pH was measured at 7.

Wildlife and Fisheries

A wide variety of birds, mammals, fish, amphibians, and reptiles exist throughout Fayette County. Whitetail deer, turkeys, fox, coyotes, raccoons, rabbits, waterfowl, beaver, muskrat, skunks, opossum, salamanders, snakes, raptors, tree species of squirrel, dozens of songbird species, and black bear can be found in the county. Each species of wildlife requires certain habitat types in order to survive and thrive. Some species have very specific habitat needs whereas others thrive in a variety of habitats.

Figure 2. Dragonfly resting on a rock at Sophia's Pond.

Both cold and warm water fish species are found in Fayette County. These include largemouth and smallmouth bass, bream, bluegill, catfish, crappie, rainbow trout, carp, bullhead, rock bass, and 16 other species.

FRHI-Specific Wildlife and Fisheries

The FRHI site provides habitats for any of the mammals and birds mentioned above. White-tailed deer, in particular, are numerous and are usually observed grazing in the grassy fields (figure 3).

Fish, on the other hand, are not that prevalent due to the nature of the streams within the Park and the AMD that affects the waters. Tzilkowski and Sheeder (2006) captured three fish species and three amphibian species during electrofishing surveys in 2005. One adult and 17 juvenile common carp (*Cyprinus carpio*) were captured from Sophia's Pond. Blacknose dace (*Rhinichthys atratulus*) and numerous creek chubs (*Semotilus atromaculatus*) were captured from Dublin Run. South Run could not be surveyed due to low water flow at the time of the survey.

Figure 3. White-tailed deer rest in one of the grassy fields.

Macroinvertebrate communities varied on the four main streams within the Park. Rhododendron Run, near its confluence with the Monongahela River, had the least impaired macroinvertebrate community. South Run had substantially more macroinvertebrate taxa (25) than Dublin Run. Ice Pond Run sites and the headwaters of Rhododendron Run all contained severely impaired macroinvertebrate communities. Ice Pond Run is, unfortunately, still impacted by acid mine drainage, but reasons for impairment of the macro community in the headwaters of Rhododendron Run remain unknown and deserve additional attention (Tzilkowski and Sheeder 2006).

Threatened and Endangered Species

Several species of Pennsylvania plants and animals have been placed on the U.S. Fish and Wildlife Service's list of Threatened and Endangered (T&E) Species in accordance with the Federal Endangered Species Act of 1973. The Pennsylvania Game Commission Web page lists the T&E species in Pennsylvania. (https://www.pgc.pa.gov/WILDLIFE/ENDANGEREDANDTHREATENED/Pages/default.aspx)

The Pennsylvania Natural Heritage Program provides assistance to determine if an endangered species occupies properties. If there will be disturbances on the property, a Pennsylvania Natural Diversity Inventory (PNDI) database search is required.

The PNDI search provides information pertaining to the location and status of important ecological resources such as plants, vertebrates, invertebrates, natural communities, and geologic features. If desired by the NPS, a PNDI search will need to be requested to determine if T&Es exist in the Park.

FRHI-Specific Threatened and Endangered Species

Wagner and Coxe (2000) reported that the Fayette County Natural Heritage Inventory identified two plants of special concern – blue mistflower (*Conoclinium coelesrinum*) and Indian woodoats (*Chasmanthium latifolium*) that occur within the Sycamore Floodplain Forest on the slopes and shores on the Monongahela River.

Recreation

- Laurel Ridge State Park contains an extensive hiking trail that traverses much of Pennsylvania's Appalachian foothills.
- The county contains the largest cave in Pennsylvania, Laurel Caverns, which is popular as both a tour and spelunking destination.
- A historic trading post that eventually was turned into a spectacular mansion is featured in Nemacolin Castle. The structure is well known for its connections to the Underground Railroad.
- The prestigious Nemacolin Woodlands Resort is located in Wharton Township. It features a five-star hotel and has received a license for a slots casino.
- A collection of waterfalls surrounding the Youghiogheny River Gorge is protected as part of Ohiopyle State Park. Whitewater rafting is a popular activity on this river.
- Sportsmen enjoy the abundant hunting and fishing opportunities are available in the 14 State Gamelands that total 7,000 acres of public land.
- Bear Run Nature Reserve's 4,200 acres are owned by the Western Pennsylvania Conservancy. The reserve has more than 20 miles of marked hiking trails, ski touring, and environmental educational opportunities.
- The Pennsylvania Department of Transportation has designated two roadways in Fayette County as Scenic Byways: The Laurel Highlands Scenic Byway (Route 381) and The National Road Heritage Park Scenic Byway (Route 40). These two segments of roadway have been given this designation in recognition of their outstanding qualities in one or more of six possible areas: archeological, cultural, historical, natural, recreational and scenic.
- The county has numerous trail systems including the Browns Run Trail, Sheepskin Trail, Youghiogheny River Trail, Indian Creek Valley Trail, and the Great Allegheny Passage.

FRHI-Specific Recreation

FRHI offers about 10 miles of trails that take hikers though early sessional fields, successional to mature forests, floodplain forests, and grassy meadows. Park personnel also conduct wildflower tours and other outdoor and indoor activities that include tours of the Gallatin House.

The Friendship Hill Association is a local private citizen organization that works in conjunction with and supports the National Park Service and its efforts to preserve and operate Friendship Hill National Historic Site. The Association sponsors FestiFall, which celebrates the cultural heritage of the region by bringing together artisans demonstrating quality handcrafts, music, and traditional foods of Gallatin's era.

Wildfire

The Pennsylvania Department of Conservation and Natural Resources (DCNR) Bureau of Forestry is responsible for protecting the Commonwealth's 17 million acres of public and private wildlands from damage by wildfire. This is accomplished by a combination of wildfire prevention, preparedness, suppression, and investigation. The Bureau works with fire wardens and volunteer fire departments to promote the latest advances in fire prevention and suppression.

Most people believe the greatest wildfire danger occurs during the summer. However, the greatest danger from and greatest number of wildfires is in the spring months of March, April, and May, and the autumn months of October and November. Ninety-eight percent of the wildfires in Pennsylvania are caused by people who either burn debris or carelessly toss a cigarette out a car window.

Regardless of the season, wildfires can occur in any month and at any time of the day, destroying valuable woodlands and wildlife habitat. Homes and buildings are threatened, not to mention the direct threat to human lives.

As can be seen from figure 4 (Bureau of Forestry Districts map), FRHI lies within the Bureau's Forbes District #4. In 2017 there were 533 fires that burned 1,650 acres, with a 10-year average of 650 wildfires burning 4,500 acres. View wildfire information. (https://www.dcnr.pa.gov/Communities/Wildfire/Pages/default.aspx)

When there is a danger of wildfire, the Bureau of Forestry will issue advisories that may develop into burn bans. Burning bans are a tool used to alert the public and protect life, property, and natural resources from wildfire.

County burn bans usually ban open burning at the request of the District Fire Warden (usually the District Forester), in consultation with at least 10 fire chiefs or 50 percent of the fire chiefs in the county, whichever is less. Any burn ban imposed under this section (Act 1995-52) should include the above burn ban definition and remain in effect for no more than 30 days. County commissioners, upon recommendation of the District Forester, may extend the ban for up to an additional 30 days.

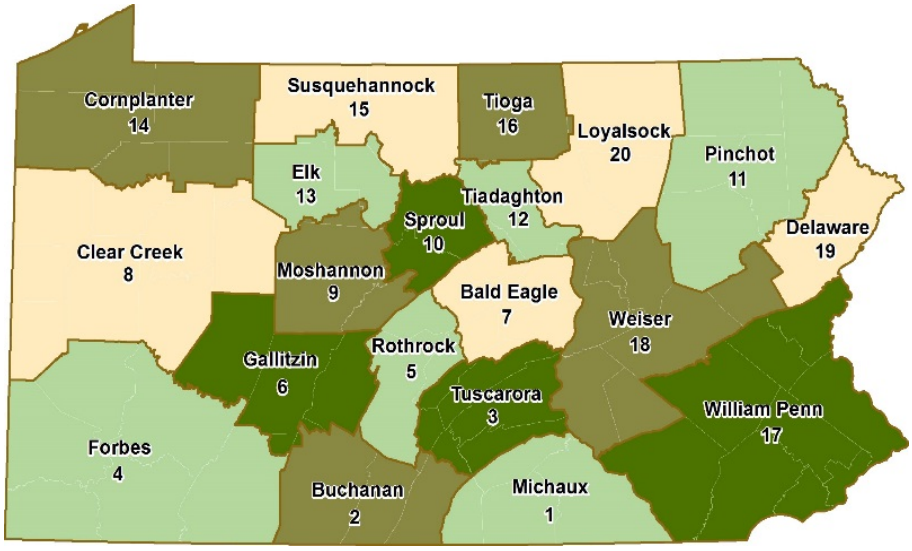

Figure 4. Bureau of Forestry Districts. (Pennsylvania DCNR)

State bans are implemented by a Governor's proclamation. State bans prohibit smoking of tobacco in any form and the building of campfires or burning of brush and other debris within woodlands or within 200 feet of woodlands within any county of the Commonwealth. A State ban is contingent on these conditions: 1) fire danger must be very high in three quarters of the State, 2) there have been 35 fires for 4

consecutive days, or 3) the entire State is in Class IV (very high fire danger) with no relief in sight. Statewide burn bans have only been implemented seven times since 1952.

Local municipalities and county offices may have additional burning restrictions or ban information. In this case it's recommended to check with local authorities to confirm where there's a ban or burning is permitted. This will alert the FRHI staff to the fire danger status.

The U.S. Forest Service Wildland Fire Assessment System (WFAS) rates the danger of wildland fire in different habitats under different weather conditions from low to extreme. Definitions of the rating classes are provided in this PDF document. (http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_003976.pdf). The most recent observed conditions and a short-term forecast are posted daily by the WFAS (follow the links under the Fire Potential/Danger heading). (https://www.wfas.net/)

The closest Pennsylvania Bureau of Forestry office to FRHI:

#4 FORBES
Edward A. Callahan
1291 Route 30
P.O. Box 519
Laughlintown, PA 15655-0519
Tel: 724–238–1200
FAX: 724–238–5000
Email: FD04@pa.gov
District Home Page

FRHI-Specific Fire History

In 1923, Al Bodine, a forester employed by the Bodine and McClelland engineer firm in Huntingdon, PA, compiled a report on the condition of the forests at the FRHI property, and outlined a timber sale and the reforestation needs (Roddy and Hammons 1986). At that time, the Pennsylvania Rail Road (PRR) adjoined the property. A fire hazard existed then, and a few fires had been started by passing trains. It was recommended to notify PRR that they would be held responsible and pay damages for any fires caused by trains in their right-of-way.

A tree planting map from 1929, which was included in the Friendship Hill Cultural Landscape Report (LeCoff 1993), showed a section of the property east of Ice Pond Run and south of the railroad tracks that had apparently been damaged by wildfire. The point of fire origin may have been along the railroad, but no further evidence has been found to determine the story behind that particular fire.

Today, the railroad passes in the north section of the property for about a mile, then crosses the Monongahela River a little north of Maple Hill, PA. The bed is raised above the surrounding woodlands, and the original railroad bed from the early part of the 1900s has been made much wider. Although these types of precautions and changes are implemented on railroad lines, trains can still cause fires. In 2017, railroads caused about 26 fires in Pennsylvania, burning 556 acres (PA DCNR 2018).

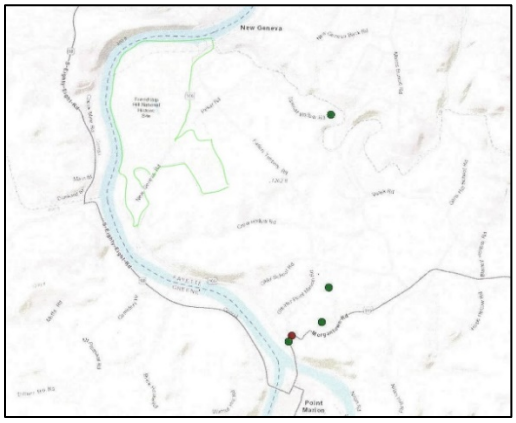

Figure 5. Fires as reported to DCNR 2002-2017. Green = debris burning, red= incendiary.

Wildfires that have been reported near FRHI and were caused by other sources, such as debris burning or incendiary, have mainly occurred around Point Marion (figure 5). Statewide wildfire incidences were down in 2017 because of higher humidity and widespread, regularly occurring rain during the spring, which helped to reduce wildfire activity.

Recommendation: In the event of a wildfire, call 911 or the Point Marion Volunteer Fire Department at 724-725-3200.

Forests of Fayette County

FRHI lies in the mixed mesophytic forest region (Rhodes and Block 2005) within the Central Appalachians ecoregion (figure 6). The mixed mesophytic forest is the richest forest in Eastern North America with literally hundreds of species of trees and woody shrubs growing in various combinations depending on elevation, aspect, slope, and soils (Frederick and Sink 2010). The most diverse stands are found on "cove sites," or protected valleys or coves on the north- and east-facing slopes. The development of these forests results from a unique set of environmental conditions consisting of high precipitation, low evaporation, moderate temperatures, and fertile soils derived from nutrient-rich sedimentary rocks. A sample of the tree species that are found in this forest type include tulip tree/tulip poplar (*Liriodendron tulipifera*), sugar maple (*Acer saccarinum*), basswood (*Tilia americana*), American beech (*Fagus grandifolia*), shrub form of American chestnut (*Castenea dentata*), yellow buckeye (*Aesculus flava*), white ash (*Fraxinus americana*), cucumber tree (*Magnolia acuminata*), northern red oak (*Quercus rubra*), butternut (*Juglans cinerea*), black walnut (*Juglans nigra*), chestnut oak (*Quercus prinus*), mockernut hickory (*Carya alba*), shagbark hickory (*Carya ovata*), pignut hickory (*Carya glabra*), American elm (*Ulmus americana*), black cherry (*Prunus serotina*), and many more.

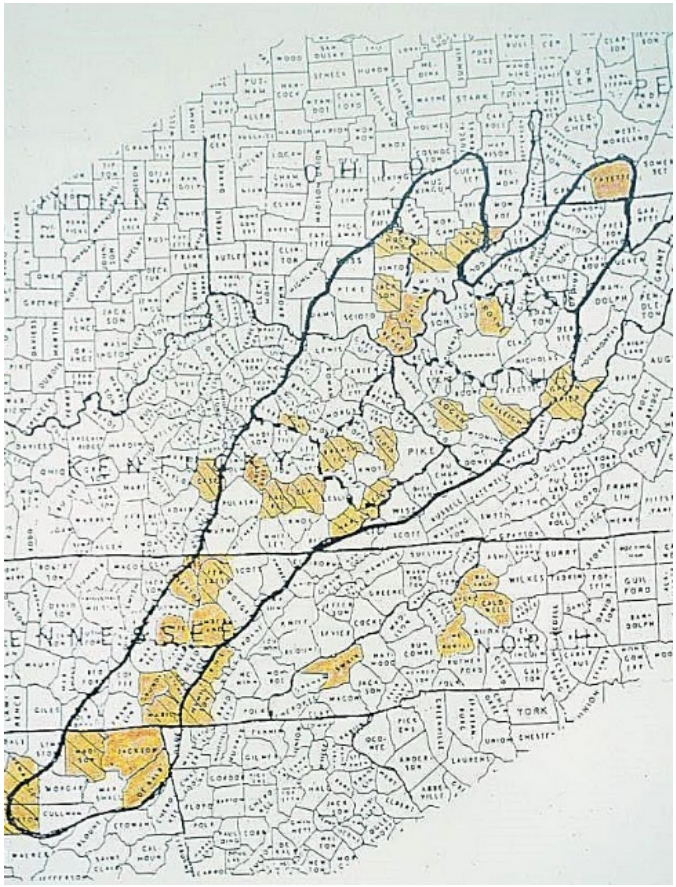

Figure 6. An outline map of the mixed mesophytic forest region. (Adapted from Braun 1950 and Kuchler 1964)

This forest type often has substantial components of eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), and spruce (*Picea* spp.), especially on moderate quality sites or where moisture becomes limiting. This forest also has mixtures of black birch (*Betula lenta*) and yellow birch (*Betula alleghaniensis*).

County Summary

Fayette County forest and agricultural lands are very productive. Forested areas are capable of growing highly productive trees for wood products and maple syrup, providing abundant wildlife habitat, improving water quality, and providing beautiful aesthetic qualities.

Implementing proper forest management projects can greatly improve wood quality and production, wildlife habitat, and the aesthetics of the woodland. Unfortunately, many landowners in the county do not reach out for assistance from resource professionals before making harvesting decisions, and the results are often degraded woodlands that will be unproductive for timber for at least 60 to 80 years.

LANDOWNER OBJECTIVES

Landowner: National Park Service, 223 New Geneva Road, Point Marion, PA 15474-1353; (724) 725–9190.

The purpose of the Friendship Hill National Historic Site as stated in the Friendship Hill Foundation Document (USDI 2013) is to "Commemorate the life of Albert Gallatin, an accomplished statesman and scholar in the decades following the creation of the United States, through the preservation of his pastoral estate." Gallatin believed that by choosing western Pennsylvania for his home, he was investing in the frontier and the future of the United States.

Gallatin's original house, his letters and writings, the estate itself, Sophia's grave, and various Gallatin collections are the fundamental resources and values the NPS interprets to achieve the purpose of the Park and maintaining its significance. The NPS also recognizes that the 10-mile trail system throughout the Park provides a popular recreational resource for neighboring communities.

The NPS is interested in a biological assessment of the Park's resources and the Forest Service recommendations, which will help them maintain the health of the forests and other resources. The NPS recognizes there are problems with invasive plants throughout the Park and has taken steps to control invasive species at some sites.

LOCATION AND REGIONAL SETTING

Friendship Hill is a 674-acre parcel of land that is located on the east bank of the Monongahela River between New Geneva and Point Marion in rural southwestern Fayette County, Pennsylvania (figure 7). The property's main house is located atop a bluff, which is the high point of the property.

FRHI is about 14 miles north of Morgantown, WV, via US-119 and about 2 hours southeast of downtown Pittsburgh, PA. It is also accessible by Pennsylvania 166, which passes through the Park.

This area of Fayette County lies within the Pittsburgh Low Plateau, a section of the Appalachian Plateau physiographic province. It's characterized by rolling uplands and rounded hills, and underlain geologically by the Casselman Formation, which was derived from marine sediments of the Pennsylvania age that are composed of shale and siltstone, with small amounts of sandstone, limestone, and coal (Shultz 1999).

Elevation within the Park ranges from about 780 to 1,140 feet. The higher elevations occur over the Monongahela Group, which contains sedimentary formations that include small portions of coal. Underground mining of coal occurred in and around the estate from the mid-1940s to mid-1950s. Strip mining also occurred until the late 1970s (Roddy and Hammons 1986). Although they are no longer in operation, these mines input vast amounts of acid mine drainage into some streams, which the Park continues to contend with today.

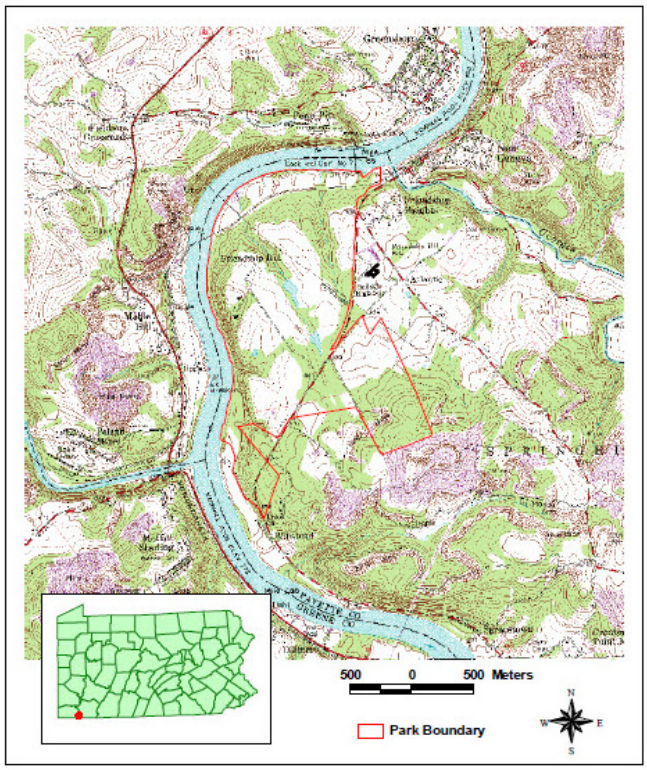

Figure 7. Location of Friendship Hill National Historic Site.

FOREST/VEGETATIVE TYPES OF FRIENDSHIP HILL NATIONAL HISTORIC SITE

When purchased by Albert Gallatin in 1786, the property had virgin forests. Gallatin and subsequent owners cleared about 317 acres for orchards, row crops, and pasture, leaving about 200 acres in woodlands by 1895 (Roddy and Hammons 1986). Today, many of the crop fields have reverted back to early successional forests, while some fields have been retained for haying.

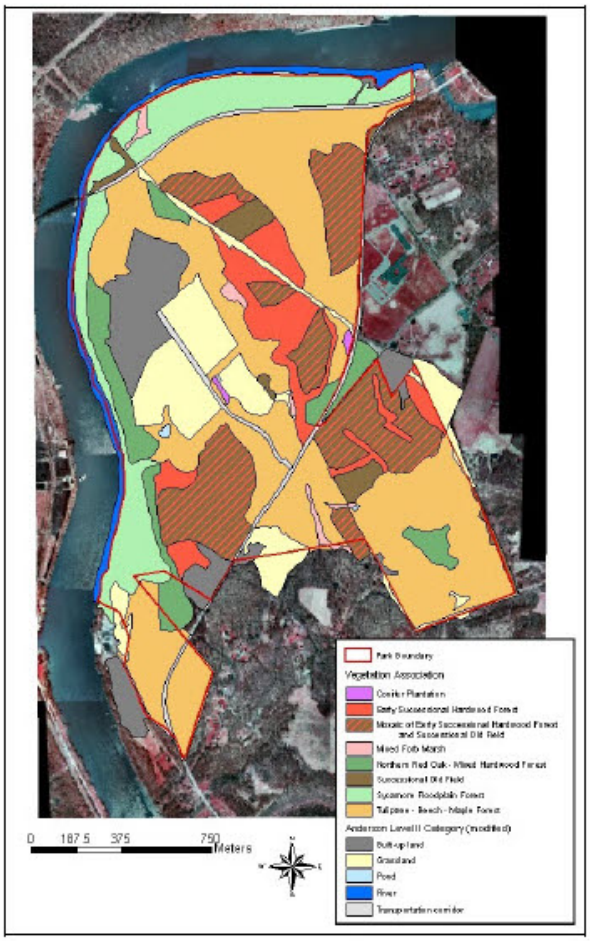

Figure 8. Vegetative classification map courtesy of Perles and others (2006).

In the late 1930s Friendship Hill owners established the Albert Gallatin Nursery to support reforestation after logging. A certificate was acquired in 1938 that permitted the selling and transporting of nursery stock. The nursery provided more than 50 varieties of trees and shrubs for sale throughout the early 1940s. The nursery no longer exists, but some of the planted conifer species can be found as single trees or in small groupings throughout the Park.

Perles and others (2006) developed a vegetation classification for the Park (figure 8), dividing it into seven vegetation types that will be described below. The term "forest types" will be used in the descriptions.

Conifer Plantations

These forests are a small component of the forest types through the Park. What remains today are the abandoned pine and spruce plantations that were planted in the 1920s and 1930s (Roddy and Hammons 1986). About 110,000 conifers and some hardwoods were planted on 90 acres beginning in 1922 as reported in 1923 by Al Bodine, a hired forester. Red pine (*Pinus resinosa*) and Scots pine (*Pinus sylvestris*) were planted on the drier and poorer soils; European larch (*Larix decidua*) and Scots pine were planted on the dry and fertile soils; and Norway spruce (*Picea abies*) was planted on the fertile river bottom soils. Other planted trees included white, Austrian (*Pinus nigra*), pitch (*Pinus rigida*), and Japanese red pine (*Pinus densiflora*); Douglas (*Pseudotsuga menziesii*) and balsam fir (*Abies balsamea*); white (*Picea glauca*) and red spruce (*Picea rubens*); eastern hemlock; Japanese larch (*Larix kaempferi*); and red oak.

Most of the conifers have been harvested, but a few small patches remain throughout the Park. One remnant stand of white pine remains at the parking area on the east side of the main road at the Trailhead Loop. These trees are more than 80 years old and are unfortunately covered with poison ivy (*Toxicodendron radicans*). White pine and Norway spruce were also found in Parcel 3, a tract of about 127 acres purchased by former owners Sherwood and Evelyn (Thompson) Miller in 1855. Christmas trees were grown on the parcel during the 1950s.

Remnants of the old plantations exist along Ice Pond Run, Parcel 3, and in the bottomlands near the northern section of the Main Loop Trail that parallels the railroad tracks. That remnant consists of white pine and 85- to 90-year-old Norway spruce that were planted in an east-west orientation, most likely along the northern edge of one of the older fields depicted on maps from the Cultural Landscape Report (LeCoff 1993).

Figure 9. Small group of eastern hemlock along Ice Pond Run.

Eastern hemlock has been found along Ice Pond Run (figure 9) and Dublin Run. Recommendations for maintaining this species will be addressed in the Forest Health section of this report.

The various conifer species are a small component within the Park and are integrating themselves with the hardwood stands. White pine reproduction was found in various stands but most likely will not dominate or completely take over any of the hardwoods forests.

Recommendations

- The only stand of conifers that could be maintained and managed is the white pine stand at the Trailhead Loop parking area. It could be intensively managed for white pine; otherwise, as the pines die off, hardwoods will most likely fill in the spaces, and the stand will eventually revert to hardwoods.
- The few Norway spruce along the access approach to the house are in good condition, and no management is needed at this time.
- The recommendation is to do nothing to manage conifers throughout the Park with the exception of the hemlocks found along Ice Pond Run near the maintenance buildings, a few along Dublin Run, and any hemlocks near the Gallatin House. They should be treated for hemlock woolly adelgid (*Adelges tsugae*). This will be addressed in the Forest Health section of this report.

Northern Red Oak-Mixed Hardwood Forests

This forest type makes up a small portion of the woodlands within the Park. It is found at the top of the western bluffs overlooking the Monongahela River, in small stands in Parcel 3, along the Columbia Gas right-of-way, and along PA Route 166. It can be found on the west side of the Gallatin House developed area and on the steep slopes of the bluffs. The western bluff/escarpment is very steep, ranges from 800 to 1,045 feet in elevation, and has slopes from 12 to 66 percent (Roddy and Hammons 1986). Species found on these slopes are black birch, red oak, red maple, elms, American beech, and dead or dying white ash.

The northern red oak forest type also occurs in parts of Sophia's Woods where the overstory consists of red and white oak, sugar maple, tulip poplar, beech, dead white ash, hickory, and a few black cherry. The understory consists of beech, a few white pine along the edge of the bluffs, mountain laurel, ash, witch hazel (*Hamamelis virginiana*), and paw paw (*Asimina triloba*).

Most of the large trees in Sophia's Woods are among the oldest trees in the Park and appear to be in the dominant crown class. These are trees with crowns extending above the general level of the main canopy. Their diameters range from 26 inches to 40 inches or more, which indicates that the growing site is good and that these trees are very old. Unfortunately, the ages on these larger trees could not be determined because of limitations with the measuring equipment. The age of one tulip poplar, however, was more

than 85 years, which indicates that the area was probably harvested in the 1930s. What remains in Sophia's Woods are secondary growth trees. The Al Bodine report (Roddy and Hammons 1986) had recommended harvesting during that time period. Because of a nearly closed canopy, there is very little reproduction on the forest floor with the exception of beech and white pine. Inadequate tree reproduction could also be the result of deer browsing.

Figure 10. A dead and down white oak is creating a gap in the forest canopy.

Codominant trees occupy the canopy throughout Sophia's Woods, and the remaining are intermediate or suppressed trees. (Canopy positions/crown classes are described in the Glossary of Terms section of this report). As the dominant trees die off, they will create large openings (figure 10). With only beech to take their place, there is a concern about beech bark disease, which will be described in the Forest Health section of this report.

Another forest type that makes up part of Sophia's Woods and is adjacent to, and in some cases overlaps, the Northern Red Oak type, is the Tulip Poplar-Beech-Maple Forests. More than likely the species of this type will mix in or seed into the Northern Red Oak type.

The Northern Red Oak-Mixed Hardwood forest type also exists in a 7-acre parcel that was originally part of the core Friendship Hill tract. The parcel lies between Route 166 and Pekar Road, and was sold to the Albert Gallatin School District. A cooperative agreement was established between the NPS and the school district to ensure the preservation of the tract. Currently the school district has no plans to develop the tract and is willing to preserve it in its existing state (USDI National Park Service 1982).

Recommendations

- Monitor the Sophia's Woods area for dead or dying ash trees and remove any whose felling length will cross any of the trails. This is a safety issue that should be addressed throughout the Park.
- Because of a high beech component among the forested areas, monitor for beach bark disease, which will be addressed further in the Forest Health section of this report.
- Monitor the dominant trees for any sign of breakage or stress.
- Monitor the gaps created by dead and down trees for invasive species, and note any tree reproduction. If there is reproduction, select up to 10 healthy seedlings or saplings in the gap and protect them with tree shelters until they can be released from the shelters and are free to grow.
- Treat or remove invasive plants that may hinder tree reproduction.

Tulip Poplar-Beech-Maple Forests

This forest type represents about half of the forests in the Park, and in some areas has developed in and/or replaced the former conifer plantations (Perles and others 2006). It occurs on the areas that are relatively flat, gentle slopes away from the river, and the bordering bluffs. The northernmost area of this type begins at the south border of the railroad tracks, then slopes up hill to the flatter areas on both sides of the Columbia Gas right-of-way, across Route 166 to Parcel 3 and the other areas east and west of Route 166. This forest type creates a lot of shade and very little ground cover.

Figure 11. Tulip poplar-beech-red maple forest type south of the railroad, with an understory of multiflora rose.

Just south of the railroad tracks, the overstory consists of tulip poplar, sugar maple, red oak, beech, elm, hickory, and black cherry (figure 11). There is also an occasional white pine and an area with about 17-20 Norway spruce planted in a somewhat east-west orientation that are within 50 feet of the Main Loop Trail. These are remnants of the conifer plantations that were planted in the 1920s. One Norway spruce was about 85 years old and 15.4 inches in diameter. A red oak was 83 years old with a height of 95 feet, indicating that the site is excellent for tree growth.

The understory includes spice bush, some sugar maple, and ash, but was lacking in other understory plants in some areas. Invasive species such as Japanese stiltgrass and multiflora rose were found.

To the east of Dublin Run, the overstory was mostly the same, but there were more red maple, white oak, and black gum intermixed with the tulip-beech-maple forest type. A few hemlocks were found along Dublin Run and show no signs of hemlock woolly adelgid at this time. The understory composition was spicebush, hickory, beech, and paw paw. The age of a 12.2-inch tulip poplar was 68 years with a height of 136 feet, indicating the site was excellent for tree growth.

A small grove of about 17 eastern hemlock was found within this forest type along the east side of Ice Pond Run, a couple hundred yards from the maintenance buildings, and easily assessable from the Ice Pond Run Loop. There were also a few Norway spruce and a red pine. Most of the overstory along the east and west side of Ice Pond Run are tulip poplar, sycamore (*Platanus occidentalis*), white oak, pin oak, red oak, black birch, black cherry, black gum, beech, and one to two black walnut (west-facing slope). The understory on the east and west side of Ice Pond Run was composed of beech, sugar maple, cherry, seedling-sized ash, multiflora rose, and Japanese stiltgrass.

About half the acreage of Parcel 3 is comprised of this forest type. Black cherry, red maple, elm, Norway spruce, birch, and both red and white oak were found.

Recommendations

- Monitor the trails and roads for dead or dying ash trees and remove any whose felling length will cross any of the trails. This is a safety issue that should be addressed throughout the Park.
- Monitor any new or recent naturally occurring gaps in the canopy for invasive plant species. Treat any invasive before it becomes established to allow for tree regeneration.

Sycamore Floodplain Forest

This forest type occurs in the low terraces and floodplain along the Monongahela River on the northern and western boundaries of the Park. Row crops were cultivated until 1975, and pasture and a pig operation were located here. The area receives periodic flooding during high rain events and therefore has severe limitations for building and road construction (USDA Soil Conservation Service 1973).

The shoreline vegetation consists of pure stands of sycamore or sycamore/tulip poplar. The upper slope vegetation, which is more diverse, includes black cherry, sycamore, hickory, tulip poplar, slippery and American elm, hackberry (*Celtis occidentalis*), beech, red oak, sugar maple, willow species, black walnut, and box elder maple (*Acer negundo*). Spicebush, white ash, sassafras (*Sassafras albidum*), box elder maple, and some paw paw were found in the understory. Invasive species include barberry (not widespread), autumn olive (not too widespread), Japanese honeysuckle, and Japanese stiltgrass. Spice bush anthracnose was found throughout the area. This is addressed in the Forest Heath section.

The canopy was not as closed as the Red Oak or Tulip Poplar forest types, especially within the sycamore stands, but more closed in the upland stands with the greater species diversity.

A mixed forb swamp lies in the floodplain east of the Columbia Gas pipeline. It is fed by Ice Pond Run.

Recommendations

- Do nothing to manage the forests on the floodplain. They are still young, and the wet soils may limit some silvicultural activities.
- Monitor and treat any newly discovered invasive plant species.
- Monitor the trails for dead or dying ash trees and remove any whose felling length will cross any of the trails. This is a safety issue that should be addressed throughout the Park.
- Consult with the Pennsylvania Bureau of Forestry regarding fire suppression planning due to the vicinity of the railroad line.

Early Successional Hardwood Forests

These forest types are former agricultural fields that were abandoned in the 1970s (figure 12). The overstory consists of tulip poplar, sycamore, black cherry, red maple, box elder maple, red and white oak, black birch, beech, hickory, and catalpa (*Catalpa bignonioides*). Species composition may change from one stand to another depending on previous disturbances and seed coming in from adjacent Tulip Poplar-Beech-Maple and Northern Red Oak-Mixed Hardwood forest types.

Figure 12. Successional hardwood forest with an understory of multiflora rose along the South Meadow Loop.

The shrub layer tree species are sparse, consisting of ash, beech, American elm, sugar maple, tulip poplar, and paw paw. Invasive species such as multiflora rose and autumn olive were prevalent, along with various forbs. Poison ivy vines, grapevine, multiflora rose, and vine honeysuckle encircle many trees. A clump of **black jetbead** was found on the Inner Loop Trail on the west side of Dublin Run and was reported to the Park Service. These shrubs are also located in large clumps along the Trailhead Loop adjacent to the white pine plantation and along Ice Pond Run Loop, southeast of the maintenance building in a 40-square-foot area. These clumps on the Ice Pond Run Loop were treated in late October 2017 and appeared to be dead in July 2018.

Recommendations

- Treat any new invasive species or those that are not well established within the Park.
- Interplant with the same species that are in adjacent Red Oak and Tulip Poplar vegetative types.
- Use tree shelters to protect the trees.
- Monitor the trails for dead or dying ash trees and remove any whose felling length will cross any of the trails. This is a safety issue that should be addressed throughout the Park.
- Inventory and select dominant, codominant, or intermediate trees for release. Reduce competition around the selected trees so they improve in vigor and can help shade out invasive plant species.

Successional Old Fields

These forest communities became established on formerly cultivated fields that were abandoned from 1974 to 1982 (Roddy and Hammons 1986.) The most common tree species are box elder maple, black cherry, tulip poplar, catalpa, American sycamore, black locust, pin oak, and ash. Many of the elm and box elder maples are misshapen (figure 13) and have epicormic branches (see Glossary). The most common shrubs are multiflora rose, both vine and shrub honeysuckle, grapevine (*Vitis riparia* and *Vitis aestivalis*), and autumn olive. Forb-dominated and grassy patches are also abundant in these areas.

Figure 13. Successional old field with dense multiflora rose and young trees off the Hidden Meadow Loop.

The abundance of invasive species will slow, if not halt, tree seedlings from growing and forming a new forest. The trees that are present are poorly formed, and many have wounds from breakage. The most drastic recommendation would be to remove everything in these stands and start over. This recommendation is what would likely be implemented on woodlands owned by a private individual, especially if wood production or wildlife habitat improvement were the main objectives. The Park Service would need to determine if it would be feasible to remove all the vegetation and either replant or allow the stands to regenerate naturally. If it's not feasible, the invasives, at least, should be treated.

Figure 14. Successional old field off the Southern Meadow Loop with planted and newly established pin oak.

The successional field in the southern section of the Park (figure 14), which is accessed by the South Meadow Loop, was planted with pin oak after the field was abandoned. Remnants of these pin oak were found in rows within the old field along with younger pin oaks and other species, which have seeded in. The soils also appear to be seasonably wet, which are preferred conditions by pin oak and sycamore.

Some sections of these fields are occupied with forbs and open grass-dominated patches surrounded by sparse-to-dense shrubs or young tree species (Perles and others 2006). These areas could be converted to pollinator habitat.

Recommendations

- Target either the Tulip Poplar-Beech-Maple or Northern Red Oak-Mixed Hardwoods forest types to reforest these areas. Interplant with these forest types as needed.
- Treat the invasive plants; otherwise the young trees cannot compete.
- Remove tree species (box elder maple) that do not fit into the target forest types otherwise they will compete with the younger trees.
- Select existing healthy seedlings or saplings and protect with tree shelters until they are free to grow.
- Inventory and select any dominant, codominant, or intermediate trees for release. Reduce competition around the selected trees so they improve in vigor and can help shade out invasive plant species.
- Select one of the smaller acreage old fields, remove all woody species, and convert it to pollinator habitat. Or select ¼- to ½-acre areas for conversion to pollinator habitat in each successional old field.
- Monitor the trails for dead or dying ash trees and remove any whose felling length will cross any of the trails. This is a safety issue that should be addressed throughout the Park.

Mixed Forb Marsh

Figure 15. Small wetland in Parcel 3.

Three of these vegetative communities occur on Ice Pond Run. Two are on the upland section of the property and the other is in the Sycamore Floodplain Forest. They are composed of riparian and wetland vegetation, and associated with poorly drained soils.

A historic wetland known as Sulfur Swamp lies in Parcel 3 within the Tulip Poplar-Beech-Maple forest type (Boone and Lisk 2002). Water flows into the swamp from the north, then through a culvert under a road that leads to Ice Pond Run. A smaller riparian wetland (figure 15), which lies between Sulphur Swamp and Ice Pond Run, was most likely part of Sulfur Swamp until the access road to the AMD treatment facility bisected it.

An old pond known as Upper Pond on Ice Pond Run was constructed in the 1950s north of Route 166. Its purpose is unknown, and unfortunately its dam failed in 1978, which drained the pond (USDI National Park Service 1983). What remains today are wetland communities that were altered by the experimental ponds that were constructed in 1986 and 1988 in the old Upper Pond bed to mitigate acid mine drainage (AMD). Remnants of the AMD system (figure 16) are still present, such as culverts, pipes, and a concrete dam. Some water from Ice Pond Run continues to flow through the ponds and diverts back to the main stem through pipes and a concrete runway.

Figure 16. Remnants of the old wetland treatment system.

These three AMD ponds are covered by wetland wildflowers, grasses, sedges, and forbs such as woolgrass (*Scirpus cyperinus*) and cattails (*Typha* species). Various invasive species can be found around the perimeter of the ponds, including multiflora rose, autumn olive, and honeysuckle.

Another marshy area referred to as the Lower Pond (Boone and Lisk 2002) was also constructed around the 1950s; its dam was demolished in October 1982. Part of the old dam is still visible on Ice Pond Run and can be viewed from the Ice Pond Run Loop. Various seeps originating in the meadows west of Ice Pond Run drain into the marsh, which has wetland vegetation such as sphagnum moss, rushes, and sedges. After Ice Pond Run passes through the old dam site of the Lower Pond, it begins to descend steeply and cut a deep gorge as it flows to the Monongahela River.

Once Ice Pond Run flows north of the railroad embankment, it splits into two branches within the Sycamore Floodplain. The area between becomes the third marsh. Boone and Lisk (2002) noted two active beaver ponds within the marsh in their hydrologic assessment. The ponds and the marsh surrounding them appear to be functioning. They lie within the 100-year flood plain and are occasionally impacted by floodwaters from the Monongahela River.

Recommendations

Boone and Lisk (2002) recommended enhancing the current marshes/wetlands because they are ecologically unique and would provide an education element to visitors. NPS is mandated to protect wetlands from degradation and restore their natural function and values.

- Treat any newly established invasive plant species.
- Restore the wetland function and values of the Upper and Lower Pond areas.

Grasslands

FRHI has been used for cropland since Albert Gallatin's time. These open, grassy fields are currently leased for haying throughout the growing season (Roddy and Hammons 1986). Mowing these fields should continue to prevent both woody and herbaceous invasives that are prevalent in the field edges from becoming established and more widespread.

Figure 17. Plot of milkweed.

Recognizing that habitat loss is a threat to monarch butterflies, park staff and volunteers have established a milkweed plot in the field between the house and main entrance drive (figure 17). The

Monongalia West Virginia Master Naturalists, a dedicated group of volunteers, provide support to the park and its plants and pollinators. When the monarchs arrive, the milkweed plot is inspected once a week to look for adults and instars.

The Park has also been altering mowing times in coordination with a local farmer. This simple act of changing the Park's mowing regime has allowed pollinators to enjoy fresh milkweed blooms and much-needed habitat throughout the growing season. Additional pollinator gardens have been established adjacent to the Albert Gallatin House.

Recommendations

- Monitor the milkweed plot for any unwanted invasive species. Mechanically remove invasives or other competition prior to establishment.
- Consider creating additional pollinator habitat in small ¼-acre sections of the other fields or in the Early Successional Fields.

Alee

Figure 18. Alee lined with pin oak.

The alee of trees is currently a monoculture of pin oak. Many of the oaks are in a state of decline with branch dieback (figure 18). Pin oak is a fast-growing pioneer or riparian species and is relatively short lived with a maximum lifespan of 120 years, whereas other oak species can live a few centuries. It is naturally a wetland tree that develops a shallow, fibrous root system, unlike many oaks, which have a strong, deep taproot when young. Some of the decline can be contributed to age and soil compaction due to the main entrance drive.

Recommendations

- Replace pin oaks that are in poor health and interplant with other species of oak, such as black and white oak, to diversify the species.

Developed Lands

Trees adjacent to the main house are in relatively good health. Some of the surface roots of trees near the employee parking area have been previously damaged from mowing (figure 19). However, the scars appear old. If mowing results in fresh wounds, the trees may be more susceptible to insect attack and disease. Trees with damaged roots should be monitored for any signs of decline

Figure 19. Old root scars.

Several oaks adjacent to the road leading to the maintenance area are in serious decline and should be pruned, removed, or monitored (figure 20).

Recommendations

- Continue to monitor trees for dieback or defects that may cause decline or breakage that results in property damage or a risk to the public.
- Maintenance contractors or Park staff need to be advised on how to protect trees and shrubs in mowed areas at the Gallatin House and elsewhere in the Park.

Figure 20. The tops of several trees along the maintenance road have died back.

Pollinator Habitat

Pollinators include hummingbirds, bees, beetles, butterflies (figure 21), bats, and flies that carry pollen from one plant to another as they collect nectar. The lives of pollinators help to produce the fruits, vegetables, nuts, seeds, and berries of farms, gardens, and orchards as well as forests, meadows, and wetlands. According to the U.S. Fish and Wildlife Service, these hard-working animals and insects help pollinate more than 75 percent of our flowering plants and nearly 75 percent of our crops. Without them, wildlife would have fewer nutritious berries and seeds, and we would miss many fruits, vegetables, and nuts.

Figure 21. Monarchs are frequent visitors to Friendship Hill.

In June 2014, President Obama directed all Federal agencies to assist in pollinator conservation to protect our Nation's food security and to help keep pollinators healthy. The President's National Pollinator Initiative is a commitment to sustaining the future of pollinators through research, policy, education, and action. As pollinators thrive and multiply, our Nation will benefit. View the Pollinator Presidential Memorandum. (https://www.nps.gov/subjects/pollinators/presidential-memo.htm)

The Xerces Society for Invertebrate Conservation is a pollinator advocate on behalf of threatened, endangered, and at-risk invertebrates and their habitats. From the world's rarest butterflies, to caddisflies that live in streams, to declining bumblebee populations, the Xerces Society is dedicated to protecting invertebrates and the ecosystems that depend on them. The Society collaborates with scientists, land managers, and conservationists to raise awareness about the plight of invertebrates and to gain protection for the most vulnerable species before they decline to a level at which recovery is impossible. Destruction of habitat, introduced species, and pesticides are all leading to the loss of invertebrate species. View information on the Xerces Society's recommended seed mixes. Recommended pollinator seeds mixes are also posted on the Penn State Extension website. (http://ento.psu.edu/pollinators)

Recommendations

- Consider increasing pollinator habitat by converting ¼- to ½-acre areas in the old successional fields and the grassy fields similar to the existing milkweed plot. Remove all woody species and treat invasives during the conversion.
- Consider delaying mowing in areas with blooming clover to allow pollinators to forage.

FOREST HEALTH

Invasive Species

Invasive species are organisms new to the Appalachian forests. Outside of their native habitats, invasive species have fewer competitors and an absence of natural controls, such as predators, parasites, and diseases, to keep their populations in check. Invasive species cause problems for native species of all kinds, from plants to birds to amphibians, through direct competition for space and resources, as well as causing long-term changes in habitat such as soil chemistry, forest composition, and forest structure.

About 66 nonnative invasive plants were found in FRHI in more than 80 survey points during a 2001-2002 survey conducted by the Western Pennsylvania Conservancy (Zimmerman and Yoder 2006). Most of the time, multiflora rose, Japanese honeysuckle, and Japanese stiltgrass were found in about half the survey plots, and were present in every vegetative community type. Other invasive species, which will be addressed in this section, are not as widely distributed, but are still serious problems where populations occur.

The Park's resource managers have made it a priority to prevent the introduction of new invasive species through awareness and continued monitoring and management of invasive species currently present. Managing for and maintaining a diverse forest composition will also help keep the forest resilient for surviving infestations of forest pests and pathogens.

Invasive Plants

Nonnative invasive plant species pose a serious threat to the forest associations in FRHI. As reported by Perles and others (2006), the Successional Old Field association contains a high abundance of invasive plant species that threaten and impede its success in transitioning to a native forest type. The management and control of black jetbead (a recent detection), Japanese barberry, Morrow's and Japanese honeysuckle, multiflora rose, Japanese stiltgrass, and autumn olive should be a priority for the Park's resource managers. Reducing or eliminating all populations of these species is not feasible or attainable, but it is recommended that the Park focus on a strategic allocation of resources in areas where the most benefits can be gained (i.e. areas where invasives are less abundant) and eradicating new populations (e.g. black jetbead and management of Successional Old Fields for a native forest type.)

Figure 22. Large black jetbead infestation along the Trailhead Loop.

Black jetbead (*Rhodotypos scandens*) is a multistemmed deciduous shrub that is native to China, Korea, and Japan. It was introduced into the United States in 1866 as an ornamental. It is widespread in the Northeastern and Midwestern United States and invades forested areas, creating a thick shrub layer (figure 22) that displaces native shrubs and restricts tree seedling establishment.

***Black Jetbead Management Recommendations*:** Small plants may be removed by hand digging. The entire root system needs to be removed; otherwise, the plant may resprout. For larger infestations, the shrubs should be cut to the ground in the fall or winter. This species can also be controlled effectively using any of several readily available general use herbicides such as glyphosate. Apply in the spring and follow the label and all State requirements.

Infestations of this new invader were found along the Trailhead Loop, Inner Loop near Dublin Run, and Ice Pond Run Loop. The infestations along the Trailhead Loop are spreading and mixed with Japanese stiltgrass. The infestations along the Ice Pond Run Loop were treated in the fall of 2017, and no resprouting was observed during the summer of 2018. Continue to monitor this site in 2019 for resprouting and retreat if necessary.

Multiflora rose (*Rosa multiflora*) is the most widespread nonnative invasive species in the Park forests. It was once planted to stabilize soil and provide wildlife cover, but it is now invading streambanks, pastures, roadsides, and disturbed areas as well as open woodlands (figure 23). It reproduces by seed and from root sprouts. Fruits are readily sought by birds, which are the primary dispersers of its seeds. It has been estimated that an average multiflora rose plant may produce a million seeds per year, which may remain viable in the soil for up to 20 years.

Figure 23. Young multiflora rose along the South Meadow Loop.

***Multiflora Rose Management Recommendations*:** Multiflora rose can be controlled both mechanically and chemically. Pulling or removing individual plants is effective when plants are small. Take special care to ensure that all roots are removed to prevent resprouting. Mowing of large shrubs can provide partial control by restricting top growth and spread, but may need to be done repeatedly. Prescribed burning can be conducted early in the growing season to control severe infestations if there is enough fuel under the shrubs. Multiflora rose is also controlled using the application of systemic herbicides directly to the foliage, which is the most effective control method. Other herbicides may be applied to cut stems or as a basal bark application, combined with a surfactant or basal oil. View additional information on herbicide application. (https://plantscience.psu.edu/research/labs/weed-ecology/research/wildland-weed-management/publications/invasive-species-quicksheets/exotic-shrubs)

Figure 24. Japanese barberry along the Trailhead Loop.

Japanese barberry is an escaped ornamental shrub that is shade tolerant and unpalatable to deer (figure 24). It is spread by birds and other wildlife that eat its abundant fruits and excrete them in new locations. Its leaves break down quickly and raise the nitrogen level in the soil, encouraging earthworms and discouraging native woods plants. It offers mice shelter from predators, encouraging them to congregate and share germs. Its dense foliage keeps the area underneath it moist so that ticks can be active almost all the time.

Japanese Barberry Management Recommendations: Japanese barberry is most effectively controlled by recognizing its appearance early and removing isolated plants before they begin to produce seed. Manual, mechanical, and chemical methods are all useful to varying degrees in controlling barberry. Reduction or removal of vegetation will provide increased light at the site, which may lead to a surge of invasive seedlings in the following year. Prepare to monitor and control these outbreaks. Mechanical controls include grubbing or pulling seedlings and mature shrubs, and repeated clipping of shrubs. Repeated mowing or cutting will control the spread but will not eradicate it. Stems should be cut at least once per growing season as close to ground level as possible. Hand cutting of established clumps is difficult and time consuming due to the long arching stems and prolific thorns. Grubbing or pulling by hand (using a Weed Wrench or a similar tool) is appropriate for small populations or where herbicides cannot be used. Barberry has shallow roots, so small plants may be pulled relatively easily when the soil is moist. Because barberry can resprout from root fragments remaining in soil, thorough removal of root portions is important. Manual control works well but may need to be combined with chemical treatments in large or persistent infestations.

Chemical control methods are best done during the fall when most native plants are dormant yet invasive plants are still actively growing. This lessens the risk of affecting nontarget plants. The barberry's green leaves will provide easy recognition and allow for a thorough treatment at this time. Winter application of chemicals has proven to be successful as well, and further lessens the risk of damaging nontarget species. Glyphosate (brand names Roundup, and for use near water bodies, Rodeo) is a nonselective herbicide that kills both grasses and broad-leaved plants while triclopyr (brand names Garlon, Pathfinder, and others) is a selective herbicide that kills broad-leaved and woody plants but does little or no harm to grasses. View additional control information. (https://plantscience.psu.edu/research/labs/weed-ecology/research/wildland-weed-management/publications/invasive-species-quicksheets/exotic-shrubs)

Recently, Japanese barberry has been implicated in the spread of **Lyme disease** (*Borrelia burgdorferi*). Researchers have noted higher densities of adult deer ticks and white-footed and deer mice under barberry because Japanese barberry has denser foliage than most native species. As a result, the plants retain higher humidity levels. Relative humidity under a barberry is about 100 percent at night. The plant exists in an umbrella-like form, so the daytime humidity drop is much more subtle under the canopy of barberry than under other plants. Ticks need humidity and become desiccated when levels drop below 80 percent. The shrubs also provide nesting areas for white-footed mice and other rodents, which are primary sources for larval ticks' first blood meal.

Japanese stiltgrass is an annual grass that is infesting areas throughout the Park (figure 25) and is established on forest trails and roads as well. This plant spreads by seed and is easily distributed by tires, animal fur and feathers, and people's footwear. Once it becomes established in a disturbed area, it outcompetes native plants, diminishing wildflowers and the growth of young shrubs and trees.

Figure 25. Japanese stiltgrass along the NPS road in Parcel 3.

After it dies back in late fall, it forms a thick layer of smothering thatch that is slow to decompose and can create a fire hazard. White-tailed deer, which do not browse the grass, may facilitate spread by browsing on native species and thereby reducing competition for the Japanese stiltgrass. It can grow up to heights of 6 feet, but usually is much shorter. The seed will stay viable in the soil for up to 5 years. Because it is an annual grass, it can be controlled or eradicated if it's treated before its seed heads mature. View a field guide to the identification of Japanese stiltgrass courtesy of the Bugwood Blog. (http://www.aces.edu/pubs/docs/A/ANR-1457/ANR-1457.pdf)

***Japanese Stiltgrass Management Recommendations*:** Mowing or weed eating is the only option for controlling large populations of stiltgrass between early August and Labor Day before it goes to seed. Mowing stiltgrass is effective along roads and trails and, when properly timed, can destroy a majority of the seed-producing plants. However, mowing alone is often only partially effective at reducing overall stiltgrass numbers. To improve the effectiveness of mowing, cut the stiltgrass as short as possible before it begins to produce seed (Richardson 2011).

A majority of the studies and research related to control of Japanese stiltgrass rely on herbicide application as a primary treatment method. Post-emergence herbicides are most effective when applied before the seed sets. Glyphosate (various trade names) and Esplanade (indaziflam) can be used to spot treat Japanese stiltgrass in gardens and planting beds. Apply both of these broad-spectrum herbicides only to the unwanted plants. View additional control information. (https://plantscience.psu.edu/research/labs/weed-ecology/research/wildland-weed-management/publications/invasive-species-quicksheets/stiltgrass)

Figure 26. Bush and vine honeysuckle along the Main Loop.

Bush and vine honeysuckles (*Lonicera* spp.) are found throughout FRHI. They include Morrow's honeysuckle and Japanese honeysuckle, which are problems in the old fields, along perimeters of parking areas, and in the forest understory.

Bush honeysuckles will invade a wide variety of natural communities with or without previous disturbances (figure 26). Affected natural communities can include lake shores and streambanks, marshes, fens, sedge meadows, wet and dry prairies, savannas, floodplains, and upland forests and woodlands.

***Honeysuckle Management Recommendations*:** Techniques for control include prescribed burning, hand pulling of seedlings, cutting, and herbicide treatments. Seedlings may be hand pulled when soils are moist. Remove all of the roots or resprouting will occur. Stems can be cut at the base with brush cutters, chainsaws, or hand tools. After cutting, apply herbicides to the cut stump either by spraying the stump with a low-pressure, hand-held sprayer or wiping the herbicide on the stump with a sponge applicator to prevent resprouting (Missouri Department of Conservation 2017).

Underplanting native species following honeysuckle removal may be necessary to re-establish a desirable composition of ground cover, shrubs, and understory trees. This may also minimize the risk of reinvasion by bush honeysuckles and other exotic species.

Autumn olive (*Elaeagnus umbellate*) is a deciduous shrub that was released in 1963 for commercial propagation (figure 27). Autumn olive has been widely planted primarily to provide food and cover for wildlife but also for screens and barriers along highways, to stabilize and revegetate road banks, and to reclaim mine spoil. Autumn olive is a rapid-growing, medium to large shrub, often reaching heights of 20 feet. The upper leaf surfaces are dark green while the undersides are covered with grayish or silver scales that give the leaves a silvery cast. Small, light-yellow flowers occur in clusters of 5 to 10 and bloom in late April and May. Small (less than ¼ inch) fleshy fruits range in color from pink to red and are produced in abundance each year.

Figure 27. Autumn olive along walkway to the Gallatin House.

Plantings for wildlife food and cover are a major factor in increased invasion of autumn olive. An individual plant can produce up to 8 pounds of fruit each season. Birds seem to be the primary vector for dispersal. It can also grow in many different sites and conditions, including disturbed areas, successional fields, pastures, open woodlands, forest edges, and roadsides. It has the ability to seed in entire areas, creating monocultures that replace native species.

Autumn Olive Management Recommendations: Small infestations of small plants can be pulled, dug, cut, or mowed fairly easily. Cutting and mowing are most effective when initiated in early summer when stored food reserves are at their lowest. In order to achieve effective control, pulling or digging must be done so that every root is removed. While this is perhaps impossible, if it is repeated frequently, small shrubs can ultimately be eliminated once their food reserves are exhausted. The key to this type of control method is to be vigilant.

Mechanical treatment alone is usually not completely effective in controlling medium-to large-size shrubs. Simply cutting the shrub off at the base will cause prolific sprouting and increase the number of stems. An effective strategy for controlling autumn and Russian olive is to kill both the above-ground portion and the root system, which eliminates the potential for resprouting. This is most effectively achieved through herbicide use.

Figure 28. Tree of heaven on the edge of woodlands.

Tree of Heaven (*Ailanthus altissima*), also known as ailanthus, shumac, stinking sumac, stink-tree, copal tree, and Chinese sumac, is an introduced weed tree that is a common problem in many areas of the United States. It has long been established in some urban and agricultural areas and is increasingly invading forests, displacing more desirable native trees. Tree of heaven is a fast-growing tree with smooth, gray bark that attains a height of 80 feet or more. It has long, compound leaves (figure 28) with leaflets that have smooth edges except for 1-3 teeth near the base, each with a small gland on the lower surface. In the winter, the tree is distinguished by gray stems with stout, blunt, brownish twigs and by the clusters of twisted papery seeds, which often hang on the trees over winter. Male flowers and cut or bruised foliage have a strong, disagreeable odor. Tree of heaven is similar in appearance to walnut and sumac.

Tree of heaven flowers are borne separately on male and female trees during the month of June. Seeds form during the summer in clusters of green-red, papery winged structures called samaras. An individual tree can produce as many as 300,000 seeds per year. These ripen in late summer and are dispersed by the wind during the fall, winter, and spring. Once they land they may lie dormant for several years until favorable conditions for germination occur.

During a 2005 inventory of FRHI conducted by the Western Pennsylvania Conservancy, it was found that tree of heaven exceeded 20 percent cover in half the areas where it was found. In some areas it was a substantial part of the canopy. The inventory report recommended that tree of heaven should be controlled, and that eradication would be possible in some areas.

Because of the high occurrence of tree of heaven in FRHI, Whiteman and Ranson (2007) developed a tree of heaven control project in 2007. Using aerial photos, 382 acres were delineated where tree of heaven was likely to occur – forest edges, abandoned fields, forest openings, and disturbed areas. Plots were established when tree of heaven was found, totaling more than 21,000 stems, of which half were seedlings. To reduce the amount of herbicide used, a decision was made to mechanically remove (hand pull) as many seedlings as possible. In late March and early April of 2007, a total of 9,193 seedlings were pulled. Following this, the first round of herbicide work was conducted during late May and early June. More than 9,700 stems were treated with a foliar application of glyphosate (Razor Pro), and approximately 2,400 trees (seedlings 7 feet and taller and trees in the 2-inch diameter class and larger) were treated with a hack-and-squirt application of Garlon 3A.

The Whiteman and Ranson control project significantly reduced the amount of tree of heaven at FRHI, eliminated it from several areas, and nearly eradicated it from the midstory and overstory. Based on the number of stems originally found within FRHI, Whiteman and Ranson concluded that it was unrealistic to eradicate tree of heaven in a single year; it was also established on adjacent private lands and would likely re-establish on FRHI lands from those seed sources. Their goal was to eradicate the seed-producing female trees from the midstory and overstory in 2007 and remove additional ones in 2008 and 2009. They documented a 95- to 99-percent decrease in female seed-producing trees after that 3-year treatment period. By the end of the 2009 treatments, very few sexually mature trees existed in the plots. The conclusion was that any seed that exists now and in the future will come from trees outside the FRHI boundary.

Tree of Heaven Management Recommendations: Penn State Extension has developed a fact sheet of control methods. (https://extension.psu.edu/tree-of-heaven)

Whiteman and Ranson's treatments proved effective and are documented in Whiteman and Ranson (2007) and Whiteman (2010). They included hand pulling seedlings in late winter/early spring and two rounds of herbicide treatments annually at each plot each year. The first round was conducted the last week of May and first week of June with a second round in late July or early August. Razor Pro was applied to tree of heaven foliage, and Garlon 3A was applied using the "hack-and-squirt" technique to all tree of heaven stems 2 inches and larger. View additional information about the hack-and-squirt method of control. (http://www.wildlifehc.org/tree-of-heaven-control-techniques/)

Well-established tree of heaven stands are only eliminated through repeated efforts and monitoring. Initial treatments often only reduce the root systems, making follow-up measures necessary. Persistence is the key to success.

Currently, tree of heaven stems were found at the paved parking lot on the bank leading up to the house and growing out of the top of the old stone cistern adjacent to the concrete trough. These should be removed.

Tree of heaven should be continuously monitored throughout FRHI. Document locations of the spread of this species and request assistance from the U.S. Forest Service Morgantown Field Office if it's making a comeback or if seed-producing trees are found.

Invasive Forest Pests and Pathogens

Forest pests introduced from other continents pose one of the most serious and urgent threats for many forests and urban and suburban trees in the U.S. (Liebhold and others 1995, Lovett and others 2006, Moser and others 2009). Invasive forest pests are an undesirable consequence of international trade and travel, and while some are not new, they inflict increasing ecological and economic damage. Gypsy moth, chestnut blight, and Dutch elm disease are well-known examples. Many others are more recent arrivals or less widespread; while the public is largely unaware of them, current and potential impacts can be severe.

Featured in the next pages are the forest insects and diseases that are affecting FRHI now or may impact the historic site in the future.

Figure 29. Gypsy moth larvae. (U.S. Forest Service photo by Karen Felton)

Gypsy moth (*Lymantria dispar*) is a potential threat to FRHI. Gypsy moth populations are currently at a very low level; historically, they have not been an issue with no reports of significant gypsy moth defoliation since the early 1990s. This area of the State, known as the Laurel Highlands, has a cooler climate and receives more precipitation than other areas of the State. These conditions are ideal for the naturally occurring gypsy moth fungus *Entomophaga maimaiga,* which keeps gypsy moth populations at low levels.

The gypsy moth passes through four stages: egg, larva, pupa, and adult. Only the larvae (figure 29) damage trees and shrubs.

When populations are high, gypsy moth caterpillars can feed on approximately 300 species of trees and shrubs. Gypsy moth egg masses are laid on branches and trunks of trees and may be found in any sheltered location (e.g. under rocks, structures, firewood, etc.).

One egg mass can contain from 500 to 1,000 eggs. The hatching of gypsy moth eggs coincides with the budding of most hardwood trees. Larvae emerge from egg masses from early spring through mid-May.

***Gypsy Moth Management Recommendations*:** Carefully monitor for gypsy moth populations on a yearly basis, especially during periods of hot and dry springs and summers. If populations increase to defoliating levels, the lack of foliage places a heavy demand on a tree's food reserves and makes it more vulnerable to attack by other organisms, such as two-lined chestnut borer and diseases.

The most productive way to monitor gypsy moth populations is to survey for egg masses during the fall and winter months, preferably after leaf drop.

Treatments to control gypsy moth are needed when gypsy moth egg masses (figure 30) reach or exceed 750 egg masses per acre. Contact the Morgantown Field Office to assist with surveys and treatment recommendations. Aerial spraying will be recommended to prevent heavy defoliation in order to protect oak species that are an important mast producer for wildlife. Allowing defoliation and subsequent mortality would open the canopy, which will increase the growth and rate of spread of invasive plants. This is especially true for areas such as the Successional Old Fields, where invasive plants are severely inhibiting regeneration of any species, or in Sophia's Woods, where gaps created by dead trees will provide open space for invasives to get established.

The impacts of possible treatments on native Lepidoptera species should also be considered in determining the appropriate treatment response to gypsy moth.

Figure 30. Egg masses on the bole of a chestnut oak. (Courtesy photo by Milan Zubrik, Forest Research Institute – Slovakia, Bugwood.org)


Figure 31. EAB exit holes in an ash near Sophia's Woods.

Scattered dead and dying white ash can be found throughout FRHI that have been attacked by **emerald ash borer** (*Agrilus planipennis*) (EAB). EAB feeds exclusively on ash trees but recently was found infesting white fringe tree (*Chionanthus virginicus*). White fringe tree is not native to Pennsylvania but is quite often planted as an ornamental tree. Tens of millions of ash trees have been lost to this pest, which usually kills ash trees within 3-4 years. Signs that an ash tree has been infested include woodpecker activity, D-shaped emergence holes (figure 31), and little or no leaf emergence. EAB can be controlled if detected early by chemical treatment of individual trees. It is expensive, and chemicals need to be applied every 1-3 years.

***Emerald Ash Borer Management Recommendations*:** Chemical control of the few remaining ash trees in FRHI is not environmentally or economically feasible. Dead and dying ash trees pose a threat to visitors because of the location of the trees to walkways, trails, and the buildings. Remove ash trees that are near trails or whose tree length could fall on a trail or building.

Hemlock woolly adelgid (*Adelges tsugae*) (HWA) is a serious pest of eastern hemlock in the Northeastern States. HWA was first reported in southwestern Pennsylvania in 2010. HWA can be controlled with chemical treatments of individual trees. The value of the trees must be considered since treatments are expensive, will have to be repeated every 5-7 years, and are a long-term investment.

HWA feeding can kill a mature tree in about 5-7 years. This tiny insect feeds on all age classes of hemlock, from seedlings to mature and old-growth trees. Dispersal and movement of HWA are associated with wind, birds, deer, and other forest-dwelling mammals. Humans also move the adelgid on infested nursery stock and during logging and recreational activities. Natural enemies capable of maintaining low-level HWA populations are nonexistent in Eastern North America.

HWA produces a white, woolly coat (figure 32) that is easily observed because it contrasts with the hemlock foliage. Look for the presence or absence of the white, woolly masses of HWA at the base of needles and on the underside of hemlock branches. In some cases, usually late summer to early fall, HWA nymphs may be present but not yet covered by a white, woolly mass. Not finding HWA on the lower branches does not mean they are not present. In many instances, high levels of HWA can be found in the upper canopy of trees while nothing is detected in the lower canopy. If you see any branches on the ground that have dropped from the upper canopy from previous wind storms, examine the foliage.

Figure 32. Hemlock woolly adelgid line the twigs of a hemlock. (Courtesy photo by The Connecticut Agricultural Experiment Station, Bugwood.org)

***Hemlock Woolly Adelgid Management Recommendations*:** Eastern hemlock is not a major component of the forest types at FRHI. A group on the east side of Ice pond Run and other individuals scattered throughout the Park were the only trees found. To date, HWA has not been detected at FRHI. But if left unattended from HWA infestations, these hemlocks will eventually die and will need to be removed due to hazards to the public.

Chemical treatment is recommended for these trees to support species diversity, reduce the potential for trees of concern, and provide shade to reduce the establishment and spread of invasive plant species currently established.

Monitor the hemlocks for HWA and contact the Morgantown Field Office if HWA is discovered.

Beech bark disease represents a unique relationship between the beech scale insect *Cryptococcus fagisuga* and the fungal pathogen *Nectria coccinea* var. *faginata.* This disease appeared on beech trees in Nova Scotia following introduction of the beech scale from Europe at the turn of the 20th century. Since then, the scale insect spread throughout New England and arrived in Pennsylvania by 1958.

Beech bark disease is a canker disease caused by the *Nectria* fungus. Feeding by the beech scale facilitates entry by the fungal pathogen. The scale insect produces white, waxy filaments that form a small but noticeable waxy crust on the tree (figure 33).

Stands of beech recently infested with beech scale may not develop cankers for several years. Eventually the *Nectria* fungus does become established. The scale and fungal pathogen work in combination to kill patches of inner bark. Cankers can expand and join to girdle and kill the tree (figure 34).

To date, beech scale has not been located in Fayette County, Pennsylvania.

Figure 33. Beech scale insects produce a white, waxy crust. (Courtesy photo by Pennsylvania DCNR – Forestry, Bugwood.org)

Beech makes up a large component of the Northern Red Oak-Mixed Hardwood and Tulip Poplar-Beech-Maple forest types within FRHI. When beech bark disease arrives at FRHI, one long-term result will be a shift in species composition — toward an increased number of beech stems. This results from heavy root sprouting after beech trees are killed by beech bark disease. In the Northeast, foresters refer to this dense regeneration as "beech thickets." Beech thickets are often impenetrable, exclude regeneration of other species, and have little value for wildlife. Sprouts that develop from parent trees that were killed by beech bark disease will also be susceptible to the disease. If root sprouts from susceptible trees are allowed to grow, the long-term susceptibility of stands to beech bark disease will continue.

Figure 34. Nectria coccinea *canker on a beech stem. (Courtesy photo by Pennsylvania DCNR – Forestry, Bugwood.org)*

***Beech Bark Disease Management Recommendations*:** Monitor beech trees for the presence of scale. Contact the Morgantown Field Office if suspect sightings are made. There are no management recommendations for beech bark disease, but some beech trees are known to be resistant to the scale insect. Leaving resistant trees intact allows these trees to disperse seed, which produces more trees that are scale resistant and fewer diseased trees in the future.

Other Threats

The following pages discuss newly discovered or introduced pests and pathogens that may (or may not) become a problem at FRHI in the next 5-10 years.

Figure 35. Adult Asian longhorned beetle and exit hole. (Courtesy photo by Kenneth R. Law, USDA APHIS PPQ, Bugwood.org)

The **Asian longhorned beetle** (*Anoplophora glabripennis*) (ALB) is a serious pest that was discovered attacking trees in Brooklyn, NY, in 1996 (figure 35). Since its initial discovery in New York, it has been found in four additional States (IL, NJ, MA, and OH). Tunneling by the beetle larvae girdles tree stems and branches. Repeated attacks lead to dieback of the tree crowns and eventually tree death. The beetle prefers maple species, but other hosts include birches, Ohio buckeye (*Aesculus glabra*), elms, horse chestnut (*Aesculus hippocastanum*), and willows (*Salix* spp.). Currently, the only effective means to eliminate ALB is to remove infested trees and destroy them by chipping and burning. To date, ALB is a pest that is regulated by the USDA Animal and Plant Health Inspection Service (APHIS); if it is discovered, eradication procedures are conducted.

***Asian Longhorned Beetle Management Recommendations*:** Annually monitor for adult beetles during the late summer months or survey for large exit holes in maple trees, especially in high-use recreational areas. Immediately contact the Morgantown Field Office if any suspect sightings or reports are made.

Over the last decade, **Bot canker** (*Diplodia corticola*) (*Dc*) has emerged as an important canker pathogen of oaks in the U.S. and Europe. In fall 2014, large overstory red oak with premature leaf browning and drop, bleeding/sooty bark cankers, and associated mortality were reported from Seneca State Forest (SSF) in Greenbrier County, West Virginia.

Surveys conducted in 2015-16 revealed crown dieback and mortality of additional red oaks throughout the SSF, with some showing prolonged radial growth decline that was visible in cross section. Disease symptoms included bleeding/sooty cankers (figures 36 and 37), crown dieback, and bark cracking as was confirmed in 2015. In 2016, this disease was also confirmed in Clearfield County, Pennsylvania.

It's not known how *Dc* colonizes oaks; however, other members of the *Botryosphaeriaceae* (family of sac fungi) generally enter plants through wounds, leaf scars, or stomata. It is suspected to be spread by air, water splash, or contaminated pruning tools. Members of this family often live as harmless endophytes until the plant is stressed, at which time they become pathogenic. The fungus may colonize dead tissue and then move into healthy tissue. To date, no links to insect vectors have been discovered.

***Bot Canker Management Recommendations*:** Contact the Morgantown Field Office immediately if any red oak trees exhibit the symptoms described above.

Figure 36. Bleeding canker of red oak from bot canker. (U.S. Forest Service photo by Danielle Martin)

Figure 37. Bleeding canker of red oak. (U.S. Forest Service photo by Danielle Martin)

On September 22, 2014, the Pennsylvania Department of Agriculture (PDA), in cooperation with the Pennsylvania Game Commission, confirmed the presence of the **spotted lanternfly** (SLF) (*Lycorma delicatula*) in Berks County, Pennsylvania, the first detection of this nonnative species in the United States. Upon determination that the potential impact on Pennsylvania's agricultural economy and natural resources was great, the PDA issued a quarantine on November 1, 2014, with the intent to restrict the movement of the spotted lanternfly. In the summer of 2018, spotted lanternfly was detected in Warren and Mercer Counties in New Jersey.

The spotted lanternfly is a plant hopper native to China, India, and Vietnam that has been introduced in South Korea and Japan (figure 38).

Figure 38. Adult spotted lanternfly. (Courtesy photo by Lawrence Barringer, Pennsylvania Dept. of Ag., Bugwood.org)

Figure 39. A female spotted lanternfly lays an egg mass on the bark of a tree. (Courtesy photo by Greg Hoover, Penn State Department of Entomology)

This pest is known to utilize 25 species of plants that grow in Pennsylvania, including cultivated grapes, fruit trees, and hardwood species. In the U.S., the spotted lanternfly has the potential to greatly impact the viticulture (grape cultivation), tree fruit, plant nurseries, and timber industries. This pest poses a significant threat to the State's more than $20.5 million grape industry, nearly $134 million apple industry, and more than $24 million stone fruit industry, as well as the hardwood industry, which accounts for $12 billion in sales.

In Pennsylvania, the spotted lanternfly overwinters in white or greyish egg masses laid on smooth bark, stone, and other vertical surfaces (figure 39). The first of four immature stages, or instars, begin emerging from the egg masses in mid-May, with a few individuals that molt to second-instar nymphs by the end of May. The first-instar nymph is black with white spots and is wingless. As it grows, the spotted lanternfly develops red patches in addition to the white spots (figure 40). Nymphs spread from the initial site by crawling or jumping up any woody or nonwoody plant it comes across to feed.

In the fall, adults prefer tree of heaven as their primary food source, mating, and egg-laying location. However, tree of heaven is not the only tree or surface the spotted lanternfly will lay eggs upon – any smooth-trunked tree, stone, or vertical smooth surface can provide a potential host for eggs masses. Manmade items such as vehicles, campers, yard furniture, farm equipment, or any other items stored outside are suitable sites for egg laying. Egg laying begins in late September and continues through late November or early December.

***Spotted Lanternfly Management Recommendations*:** Survey areas with tree of heaven during the fall and winter months. Egg masses may be found on other smooth-surfaced outdoor items, such as lawn furniture, stone and brick work, and outdoor recreational vehicles. The egg mass poses, perhaps, the greatest risk for accidental transport of the spotted lanternfly to new areas.

To date, spotted lanternfly is a pest that is regulated by USDA APHIS. If it is discovered, eradication procedures are conducted. Immediately contact the Morgantown Field Office if any suspect sightings or reports are made.

Figure 40. One of the spotted lanternfly nymph stages.

Unknown Spice Bush Disease. Spice bush is a member of the laurel family that is native to Northeastern North America. It's usually found in the understory of forests in moist, rich soils derived from limestone. The dark-green leaves are very aromatic. Many animals feed on the leaves, twigs, and berries, including white-tailed deer, Eastern cottontail, and opossum. More than 20 species of songbirds and gamebirds also feed on spicebush. The berries are a favorite food of wood thrush.

Spice bush is showing signs of decline from an anthracnose caused by the fungus *Colletotrichum fioriniae* that has been recorded as killing shrubs in other parts of the State. Anthracnose is a group of diseases that cause dark, sunken lesions on leaves, stems, flowers, and fruits. Anthracnose infects many deciduous and evergreen trees and shrubs, and in some regions also infects fruits, vegetables, and turfgrass. Infected plants develop dark, water-soaked lesions on stems, leaves, or fruit. The centers of these lesions often become covered with pink, gelatinous masses of spores, especially during moist, warm weather.

Figure 41. Cankers on the stem of a spice bush in the Sycamore Floodplain.

Pitted cankers form along the spice bush stems (figure 41), which eventually girdle the shrub. Currently very little is known about this disease, and researchers from West Virginia University and the U.S. Forest Service are working on this issue.

This disease of spice bush is being documented in this report because Park personnel should be aware of the problem and may observe spice bush dying throughout the Park in the future.

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GLOSSARY OF TERMS

AGE CLASS: A group of trees in a stand that are at or nearly the same age.

BASAL AREA: Total area of cross section of stems measured at breast height (4½ feet above the ground), usually expressed in square feet per acre.

CROWN CLASS: A class of tree based on crown position relative to crowns of adjacent trees.

- **Dominant:** Trees with crowns extending above the general level of the main canopy of groups of trees.
- **Codominant:** Trees with crowns forming the general level of the main canopy in groups of trees, receiving full light from above and comparatively little from the sides.
- **Intermediate:** Trees with crowns extending into the lower portion of the main canopy of groups of trees, but shorter in height than the codominants. They receive little direct light from above and none from the sides.
- **Overtopped (Suppressed):** Trees of varying levels of vigor that have their crowns completely covered by the crowns of one or more neighboring trees. These trees receive little, if any, direct light.

DIAMETER AT BREAST HEIGHT OR D.B.H: The standard for measuring trees. DBH refers to the tree diameter measured at **4.5 feet** above the ground.

EPICORMIC BRANCHING: Shoots arising from adventitious or dormant buds on the stem or branch of a woody plant, often following exposure to increased light levels or fire.

FOREST HEALTH: Forests can be considered healthy when there is a balance between growth and mortality and the forest has the resiliency to react and overcome various forest impacts. Potential forest stressors include insects, pathogens, weather, climate, pollution, and others.

FOREST TYPE: Similarity of composition and development (as in two or more stands of trees) due to the impact of corresponding physical and biological factors; sometimes a forest association.

GIRDLE or GIRDLING: Also called ring-barking: the complete removal of a strip of bark (consisting of cork cambium or "phellogen", phloem, cambium, and sometimes going into the xylem) from around the entire circumference of either a branch or trunk of a woody plant.

HAZARD TREE: see TREE OF CONCERN

OLD-GROWTH FOREST: Forests that contain a wide range of tree sizes and ages; a deep, multilayered crown canopy; diverse shrub and forb layers; and significant accumulations of coarse woody debris including snags and fallen logs. Stands typically appear all-aged rather than even-aged. Large trees can be evidence that the old growth ecosystem has had sufficient time to develop diverse structure, although not all old growth stands have large trees, particularly on less productive sites. Large trees can exist in relatively young stands on very productive sites.

OPEN BURNING: Defined as the ignition and subsequent burning of any combustible material (garbage, leaves, grass, twigs, litter, paper, vegetative matter involved with land clearing, or any sort of debris) out-of-doors either in a burn barrel or on the ground. The use of propane or gas stoves, charcoal briquette grills, or the use of tobacco in any form is not covered under county burn bans. Camp fires are allowed in the fire rings that confine and contain the camp fire in a designated State, Federal, or Department of Environmental Protection licensed campground.

PRESCRIPTIONS: The written instructions by a forester for the preparation and administration of a resource management practice.

REGENERATION: Seedlings or saplings that are present in the understory prior to removal of any overstory.

RIPARIAN ZONE: The immediate area influenced by the presence of a concentration of water; the banks of streams, lakes, or marshes.

SITE CLASS: A classification of site quality, usually expressed in terms of ranges of dominant tree height at a given age or potential mean annual increment at culmination.

SITES: Areas considered by ecological factors with reference to capacity to produce forests or other vegetation; the combination of biotic, climatic, and soil conditions of an area.

SIZE CLASSES: Tree sizes recognized by distinct ranges, usually of diameter or height.

STAND: A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit.

- **Mixed Stand** - A stand in which there is a mixture of species.
- **Pure Stand** - A stand composed of essentially a single species.
- **Stratified Mixture** - A stand in which different species occupy different strata of the total crown canopy.

SUCCESSION (ecological): A process of community development that involves changes in species structure and community processes over time.

SUCCESSIONAL STAGE: One in a series of usually transitory communities or developmental stages that occur on a particular site or area over a period of time. Eventually, on most sites, a relatively stable, self-perpetuating stage, called a climax, is attained.

SUSTAINABLE: To produce a steady, predictable quantity of all resources over time.

TREE OF CONCERN: A tree that has the potential for any type of failure due to a structural defect that may result in property damage or personal injury. Also known as “hazard trees.”

TREE SHELTER: Generic name for a solid (or mesh) tube that is placed over a seedling to provide favorable environmental conditions for seedling growth.